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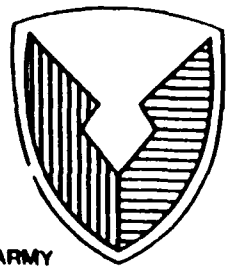

INSTRUMENTATION DEVELOPMENT

FINAL REPORT

THE MULTIPLE SUBSYSTEM TIMING METER (MSTM)

BY

BRUCE BUZZO

SEPTEMBER 1989

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TECHNICAL SUPPORT DIVISION
ENGINEERING SUPPORT BRANCH

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The Multiple Subsystem Timing Meter (MSTM) was developed to record operational times for the turret drive, turret power, infrared sight unit and the Stabe system on the Bradley Fighting vehicle. One resolvable problem was encountered with the high dust concentration during field testing. (No Failures Occurred during field testing).

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FOREWORD

This report was prepared in accordance with TECOM Regulation (Draft) 70-18; Research, Development, and Acquisition for INSTRUMENTATION DEVELOPMENT AND ACQUISITION, 1 April 1989. It documents the development of instrumention currently in use that displays and maintain accurate operational time of critical components in the Bradley Fighting Vehicle(s). This project was conducted by the Engineering Support Branch, Technical Support Division, Materiel Test Directorate, U.S. Army Yuma Proving Ground to enhance and expand its test data collection capabilities.

SECTION 1. SUMMARY

1.1 Background

In testing Army vehicles such as the Bradley Fighting Vehicle (BFV), it is necessary to maintain accurate operational time records of critical component and\or subsystems. This data is required to determine the mean-time between failures (MTBF) or service life of the components or subsystems.

The Mobility Branch of Yuma Proving Ground Test Engineering Division tasked the Engineering Support Branch to design a resettable instrumentation system, capable of recording turrent subsystem operating times and displaying them in tenths of hours without adversely affecting the subsystems on which data was to be collected. Originally, operational times were to be collected on three turrent subsystems of the BFV: turret power, turret drive, and the Stab system. However, each instrumentation system contained four meters, and, after field testing, the fourth meter was used to obtain operational time data on the Infrared Sight Unit (ISU).

1.2 Description of Instrumentation

The instrumentation designed to satisfy the requirement was a multiple subsystem timing meter (MSTM) consisting of four Red Lion General Purpose Miniature Liquid Crystal Display Electronic Timers, model CUB3TR11/A (see Figure 1). The four meters were housed in an aluminum case. The final design of the MSTM has one normally closed push button switch to reset the four meters in one operation.

To accommodate a high dust environment test scenario, it was necessary to prevent dust from entering the MSTM housing. This sealing of the housing was required due to the sensitivity of the electronic hour-meters' display contacts. This was accomplished by the use of room temperature vulcanizing (RTV) silicone sealant.

The major component of the instrumentation, the digital electronic hour-meter, model CUB3TR11/A, is an off-the shelf product designed to be used as an hour-meter for time measurement applications to the tenth of an hour. The hour-meter is resettable. This model accumulates time and displays it on a 5-1/2-digit Liquid Crystal Display (LCD). It is capable of displaying a total of 19,999.9 hours before overflow of the display. An indicator, resembling a colon (located to the left of the display), will blink (along with the decimal point of the tenth hour meter) whenever the hour-meter is actuated with the required 10 to 130 volts AC/DC. The reset feature of the hour-

meter allows the user to periodically measure elapsed time and reset the accumulated time to zero.

No external power source was required for the display since the internal lithium battery provides up to ten years of uninterrupted service. The voltage required for operation of the timing circuit on the hour-meter is 10 to 130 volts AC/DC (Ref. 1, Appendix B).

1.3 Objective

a. To enhance/expand the subsystem operational time data collection capability during mobility/durability vehicle testing.

b. To design, with state-of-the-art hardware, a reliable and resettable instrumentation system capable of recording, to the tenths of an hour, operation times of critical turrent subsystems of the Bradley Fighting Vehicle.

c. To field test the instrumentation system to determine its reliability, adequacy of data collected, and adaptability to other vehicles.

1.4 Summary of Results

The MSTM successfully recorded, to tenths of hours, subsystem operational time of four BFV turrent subsystems during a 1,500-mile Comparison Production Test at YPG. The turrent subsystems on which data was collected were: turret power, turret drive, Stab, and Infrared Sight Unit (ISU). The data provided by the MSTM was considered more accurate and reliable than data provided by previously used electro-mechanical hour-meters.

1.5 Analysis

The MSTM instrumentation utilizing the electronic resettable hour-meters provided accurate and reliable timing data on the BFV turrent subsystems.

The MSTM instrumentation was considered adaptable for collection of operational time data on other vehicle subsystems.

1.6 Conclusion

The instrumentation developed in this project and field tested on the BFV turrent provides accurate and reliable operational time data (to the tenth of an hour) for vehicle subsystems capable of delivering 10 to 130 VAC/VDC to the hour-meter when the vehicle subsystem is activated.

1.7 Recommendations

It is recommended that the MSTM be used when accurate and reliable operational time data for the calculation of Mean-Time-Between-Failure (MTBF) on vehicle subsystems and other operational time data is required during vehicle testing. It is further recommended that the digital electronic hour-meter be used to replace the electro-mechanical hour-meter (NSN 6645-00-089-8842) currently being used to record operational time data.

SECTION 2. DETAILS OF TASK

2.1 Rationale

Electro-mechanical hour-meters (NSN 6645-00-089-8842) were used initially for collecting turrent subsystem data in Comparison Production Tests of the Bradley Fighting Vehicle (BFV) at YPG. These meters proved inadequate for collecting operational time data for subsystems on the BFV turrent for two reasons:

a. The hour-meters drew too much current (approximately 3.8 amps), disabling the Stab system.

b. For those turrent subsystem circuits not disabled by the high current draw, another problem existed. The functioning of the spring wind-up mechanism of the electro-mechanical hour-meter created a 30-45 second data discrepancy (time-lapse) because the meter would have to wind down before it would stop recording time. Wear in both the spring and the electric points produced inaccuracys and eventual failure of the hour-meter. The data produced were considered statistically inadequate where subsystem operational time data was required to be collected in intervals of less than one second (displayed in tenths of hours).

Therefore, an instrumentation design project was initiated to develop alternate equipment appropriate for determining (in tenths of hours) the operational time for the BFV turrent subsystems.

2.2 Objectives

The objectives of this instrumentation project were:

a. To enhance/expand the subsystem operational time data collection capability during mobility/durability vehicle testing.

b. To design a reliable, resettable instrumentation system capable of recording, to the tenth of an hour, the operational times of components/ subsystems of the BFV turrent.

c. To utilize, state-of-the-art, off-the-shelf hardware for the instrumentation.

d. To field test the instrumentation and determine its adaptability to other vehicles.

2.3 Requirements

The instrumentation system should be suitable for measuring, to the tenth of an hour, the operational times for BFV turrent subsystems to include the turret power, the turret drive, STAB system (commander's palm switch and gunners' palm switch activation), and one other subsystem as required.

The instrumentation should also be:

a. Resettable to zero

b. Have a self-contained power unit for the display

c. Require low current for timer activation

d. Provide a wide range of operational voltages

e. Be easy to install in mobility vehicles

f. Interface with the appropriate Simplified Test Equipment/Tank (STE/Tank) diagnostic system

g. Be suitable for the desert test environment (high temperatures and dust content)

2.4 Assembly

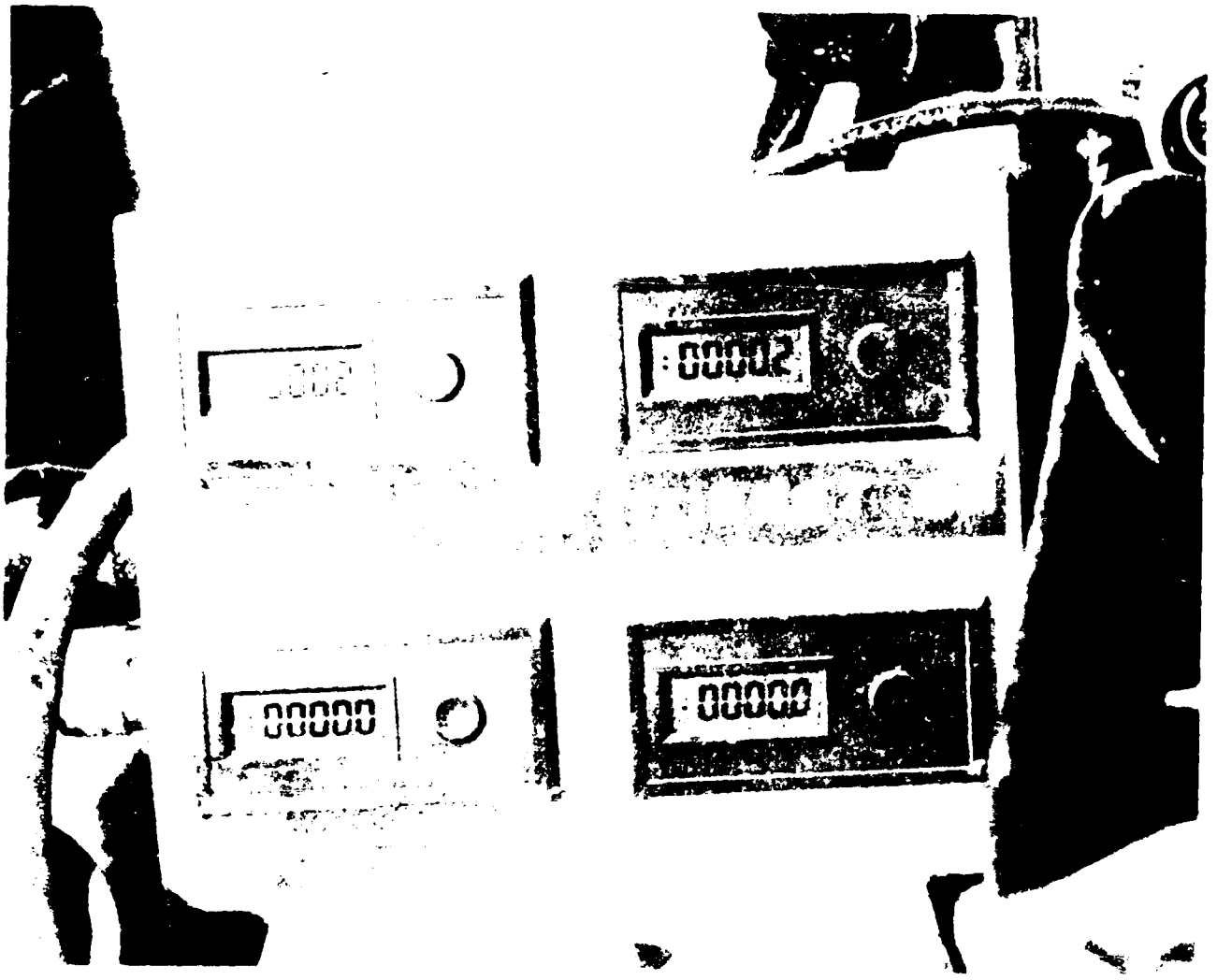
a. Off-the-shelf hardware, Red Lion General Purpose Miniature Electronic Timers, Model CUB3TR11/A, were selected and procured for the meter.

b. An aluminum housing was fabricated to hold four CUB3TR11/As. (See Figure 1)

c. A switch was installed internally (in the back of the housing) to reset all four meters in one operation. The switch was accessed through a hole in the housing covered with tape to prevent entry of dust. (See Figure 2)

d. Wiring was provided to interface the instrumentation system with the STE/Tank system in the BFV turrent. (See Figure 3)

e. The instrumentation was installed in the BFV turrent according to instructions in the Bradley Fighting Vehicle brake out box and card extender usage manual for monitoring the Turret Drive, Turret Power, Infrared Sight Unit and Stab operational time. A manual of the pinouts locations is in Appendix A. Figure 4 is the schematic for the MSTM.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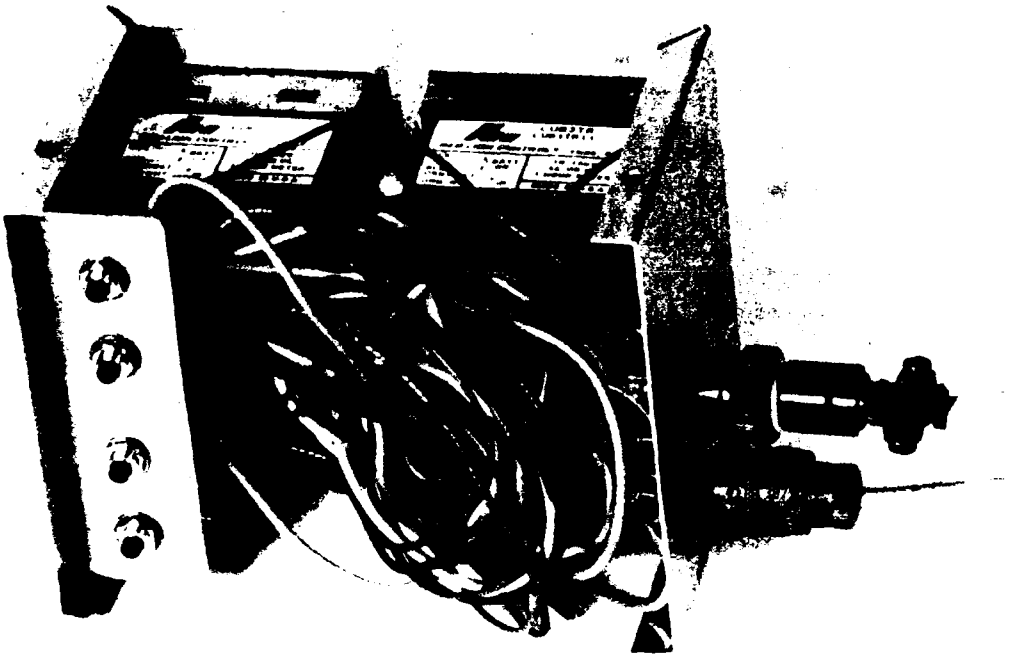


FIGURE 2. Internal View of MSTM
(Individual Reset Switches)

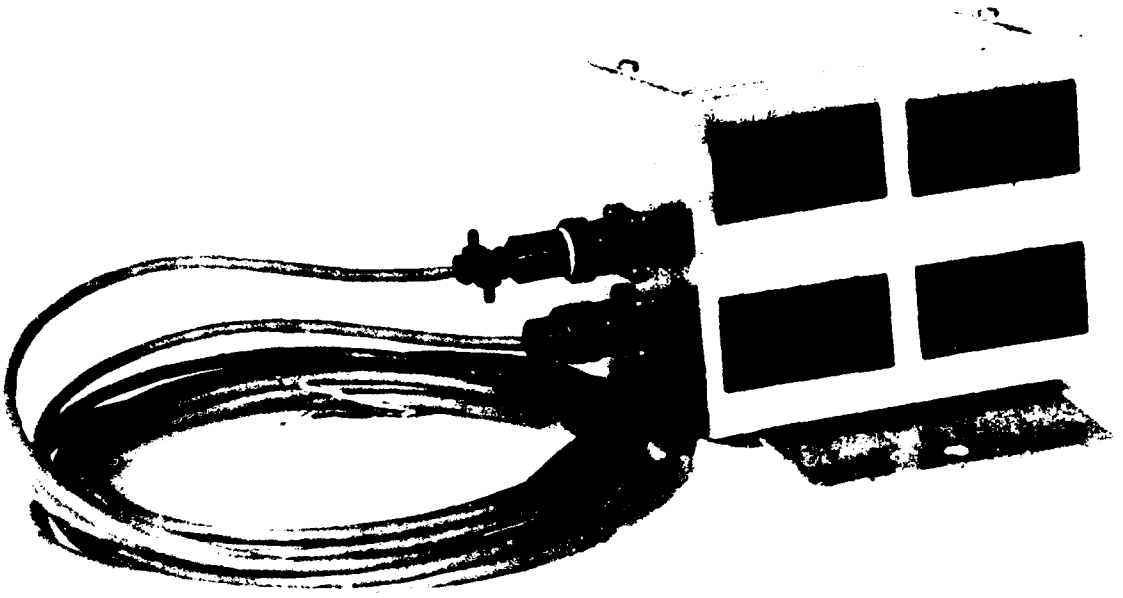
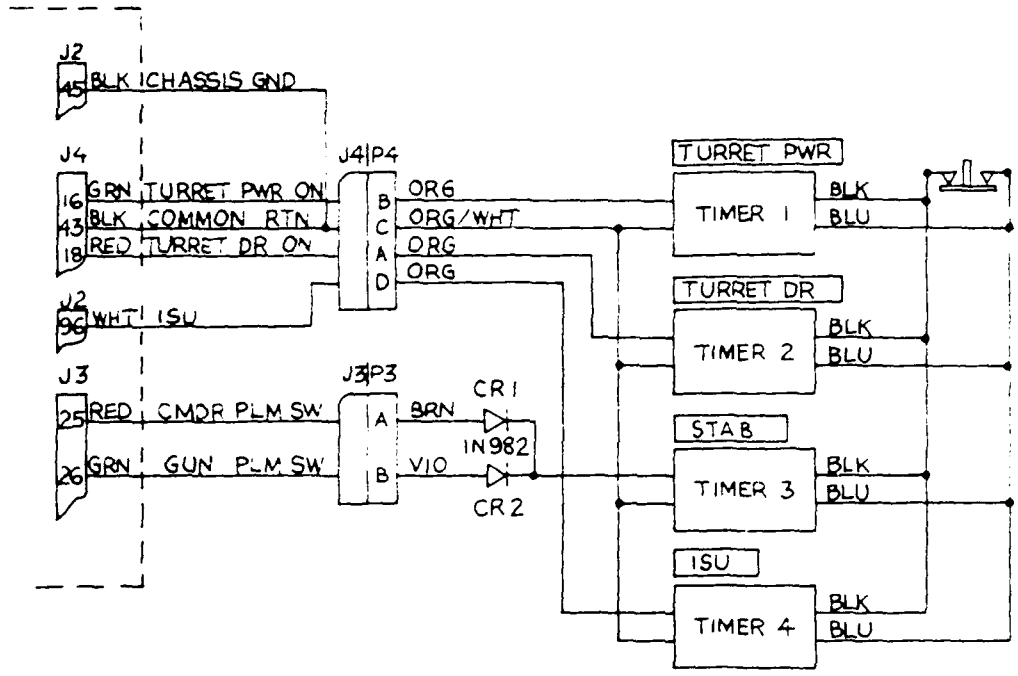


FIGURE 3. MSTM with Connecting Wiring



BRADLEY TIMER

GJB
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NOTES

1 SWITCH IS NORMALLY CLOSED. OPEN TO RESET.

2 TIMER P/N: CUB3TR11/A

FIGURE 4. MSTM Schematic

2.5 Test of Meter

The multiple hour-meter instrumentation system, MSTM, was installed in the turrent of BFVs undergoing firing tests at U.S. Army Yuma Proving Ground during a 500-mile Comparison Production Test. The meter provided operational time data on four subsystems: the turret drive, turret power, Stab, and ISU.

2.6 Test Results

The MSTM, using the digital hour-meters, worked well for collecting operational time data on the BFV turrent subsystems. The MSTM enhanced and expanded the subsystem operation time data collection capability.

One problem was encountered during the field testing. Because of the high dust environment inside the BFV turrent, dust filtered inside the instrumentation housing. This caused some of the contacts between the LCD display circuit and the timing circuit to become open, causing some of the display segments to work improperly. Only the display was affected, the timing circuit continued to operate. The hour-meters were cleaned and the display capability was restored.

To correct this problem, the instrumentation housing was sealed with RTV silicone sealant to prevent the infiltration of dust into the circuitry. Testing continued. No further problems associated with dust were encountered after the use of RTV silicone sealant.

The instrumentation was installed in the BFV turrent according to instructions in the Bradley Fighting Vehicle brake out box and card extender usage manual in Appendix A.

Originally the Project Engineer requested each digital time meter to be individually resettable. The reset switches were internal with no external access, requiring opening the instrumentation housing to reset an hour-meter. After field testing on the BFV turrent subsystems for about one year, it was requested by the Project Engineer that a single externally accessible reset switch be installed for resetting the four hour-meters in one operation. The MSTM was modified to provide a single internal reset switch. Access to the single reset switch was through a hole at the back of the instrumentation housing. Duct tape was applied over the hole in the instrumentation housing to prevent dust infiltration.

At the beginning of field testing, only three of the four hour-meters contained in the MSTM were used. Later the Project

Engineer requested that the fourth hour-meter be connected to monitor the turrent Infrared Sight Unit (ISU).

2.7 Analysis

The MSTM functioned as required.

The MSTM enhanced and expanded the collection capability of subsystem operational time data.

The turrent subsystem data collected/recorded by the instrumentation system were accurate and reliable.

The Red Lion General Purpose Miniature Electronic Timers, model CUB3TR11, proved to be appropriate and reliable hardware for the MSTM instrumentation system.

A single internal reset switch, accessed through a hole at the back of the meter, proved satisfactory for tests conducted on the BFV turrent subsystems.

2.8 Conclusion

The MSTM enhanced and expanded the subsystem operational time data collection capabilities.

The resettable MSTM designed for recording (to the tenth of an hour) subsystem operations on the BFV turrent, provided accurate and reliable operational time data for the determination of MTBF.

2.9 Recommendations

The resettable MSTM is recommended for use as an effective and reliable instrumentation system to:

a. Provide operational time data, to the tenths of an hour, on subsystems/components of mobility vehicles where special circuitry is not required to meter the subsystem/component.

b. Replace the electro-mechanical hour-meters currently used for timing subsystems in test vehicles.

APPENDIX A. ILLUSTRATIONS

The following pinout locations were determined to be the correct location for attaching the MSTM into the circuitry used by the subsystems being metered.

J2 At diagnostic test point J2:

- 45 pinout 45 is for the ground
- 96 pinout 96 is energized when ISU is activated.

J4 At diagnostic test point J4:

- 16 pinout 16 is energized when turret power is on.
- 43 pinout 43 is the common ground.
- 18 pinout 18 is energized when the turret drive is on.

J3 At diagnostic test point J3:

- 25 pinout 25 is energized when the Commander's Palm Switch is on.
- 26 pinout 26 is energized when the Gunners' Palm Switch is on.

CR1 and CR2 represent 1N982 diodes used as blocking devices to prevent reverse polarity from effecting the non energized gunner's or commander's palm switch.

Timer 1 through Timer 4 indicate function (subsystem) timed.

S1 is the common reset switch.

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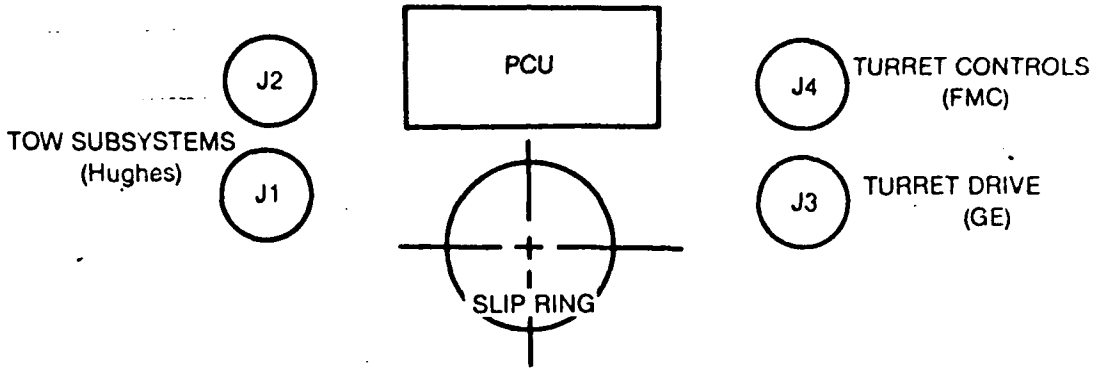
BRADLEY FIGHTING VEHICLE
BREAK OUT BOX AND CARD EXTENDER USAGE

The Break Out Box and Card Extender are troubleshooting tools which are valuable when isolating faults in the turret system. They are intended to be used by experienced technicians who know the Bradley Turret Systems, Fault Isolation techniques, and are familiar with the turret schematic diagrams.

To hook up the Break Out Box or Card Extender, refer to the installation procedure.

Three turret systems can be monitored at the Diagnostic Test Points.



TURRET CONTROLS

All FMC interface test points and approximate signal values for the J4 (TMDE) connector are listed on the following chart. These signal values are most useful in troubleshooting turret electrical faults.

The chart lists the condition required to monitor the proper TMDE (J4) signals, with a multimeter. Each signal is traceable to the turret schematic.

TURRET DRIVE

The GE chart lists the test point data that may be measured at the J-3 TMDE (GE) connector. All but TP-11 and TP-12 may be measured with a multimeter. An oscilloscope is recommended for these two measurements.

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TOW SUBSYSTEMS

The "HAC" (TMDE J-2 connector) chart lists all the relative test point functions but requires one or more of the following instruments to monitor dynamic status of the TOW Subsystems. Oscilloscope, Spectrum Display Unit (SDU), strip chart recorder (2 channel minimum) and a multimeter.

These signals are considerably more difficult to monitor due to the fact that some are momentary, alternating or modulated, or pulsed in a specific time sequence. Additionally, conventional test equipment may "Load" down some circuits (oscillators and amplifiers) causing erroneous readings to be taken.

The Card Extender is used when it becomes necessary to isolate a fault down to component level in the TDB. It provides access to test points and input/output signals on the PCB's. Information gained at this level can be used to pinpoint a fault down to an individual PCB or a component on the card.

When the card extender is plugged into the TDB and the PCB is installed in the extender box, each test point (1-70) corresponds to the same pins on the card connector. Readings can then be made at the test points or directly on the PCB in the card extender box.

TURRET DRIVE

The turret drive (J3) test points are traceable to the GE ECA PC board schematics, by use of the 2W202 cable wiring diagram and the ECA wiring diagram.

TOW SUBSYSTEMS

The tow system (J2) test points are traceable by use of the schematics and wiring diagrams for the CGE, tow launcher and ISU.

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FMC TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J4	CONDITIONS
01	Vehicle Prime Power	+24	7	
02	Logic Power	+9	8	
04	Backup Battery	+24	10	
05	Launcher Up/Down CMD	+15	11	
06	Launcher Down Switch	+9	12	
07	Tow on Switch	+24	13	
08	Missile 1 Select Switch	+9	14	Launcher Up, in Tow Mode.
09	Missile 2 Select Switch	+9	15	Launcher Up, in Tow Mode.
10	Turret Power (Primary) On	+24	16	
11	Turret Power (Essential) On	+24	17	
12	Turret Drive On	+24	18	
13	Stab On	+15	19	
14	Rotor Fan (Off)	+24	20	When Fan is Off.
15	Tow Abort Switch	+9	21	
16	Arm Switch	+24	22	
18	Trigger Relay Reset	+24	24	
19	Logic Reset	+24	25	
20	Misfire Switch	+5	39	
21	AP SS Switch	+24	26	
22	HE SS Switch	+24	27	
23	AP LO Switch	+24	28	
24	HE LO Switch	+24	29	

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FMC TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J4	CONDITIONS
25	AP HI Switch	+24	30	
26	HE HI Switch	+24	31	
27	7.62 Select Switch	+24	32	
28	LO Ammo Override	+9	33	
29	Grendade Launcher On Switch	+24	34	
30	Grenande Trigger Switch On	+24	35	
31	7.62 Low Ammo Switch	+5	74	
32	AP Low Ammo Switch	+5	75	
33	HE Low Ammo Switch	+5	76	
34	Crew Fan Off	+24	36	When Gun Is Fired.
35	Crew Fan On	+24	37	15 Seconds after Trigger Release.
36	7.62 Trigger Solenoid	+24	38	
37	HE Feed Solenoid	+24	44	
38	AP Feed Solenoid	+24	45	
40	AP Feeder Position SW	+12	47	
41	HE Feeder Position SW	+12	48	
43	Breech locked switch	+5	85	
44	Normal Shutdown Switch	+5	86	
45	25mm Gun Field Voltage	+24	55	
46	25mm Mtr/Armature Volt.	+24	56	
47	25mm Gun Sear Sol Volt.	+24	57	
48	Sear Position Switch	+24	58	
50	Sensor Power	+24	60	

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FMC TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J4	CONDITIONS
51	Sear Indication Switch	+5	40	
52	Cargo Hatch Closed	+24	66	
53	Driver Hatch Closed	+24	67	
54	Driver Hatch Not Popped	+24	68	
55	Cargo Hatch Not Popped	+24	69	
56	Gun Elevation -1 DEG.	+12	70	
57	Tow Elevation -13 DEG.	+12	71	
58	Encoder Output (G4)	+5	50	
59	Decoder Output (A0)	+5	51	
60	Encoder Power Input	+5	52	
61	TP1 Power Input	+5	53	
62	Hatches Not Closed	+5	62	
63	25mm Fire Inhibit	+5	63	
64	7.62 Fire Inhibit	+5	64	
65	Missile Fire Inhibit	+5	65	
66	Drive Power Inhibit	+24	72	
72	Tow Launcher Up	+9	108	
73	Launcher Stowed	+9	109	
74	Trigger Power	+9	78	
75	Gunner Trigger Command	+9	79	
80	3 MPH Tow Inhibit	+24	84	
81	Tow Buss Power	+24	89	
82	12X Power (Day)	+24	90	
83	Tow Mode Not Selected	+24	77	

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FMC TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J4	CONDITIONS
84	Tow Trigger Command	+24	91	
85	Latched Trigger	+24	92	
86	Missile No. 1 Not Present	+5	41	
87	Missile No. 2 Not Present	+5	42	
89	Actuator Extended A	+24	94	
90	Actuator Extended B	+24	95	
91	Actuator Retract Command	+24	96	
92	Actuator Retracted A	+24	97	
93	Actuator Retracted B	+24	98	
94	Missile No. 1 Arm Signal	+24	99	With MTC in place (Reset)
95	Missile No. 2 Arm Signal	+24	100	With MTC in place (Reset)
96	Rotor Exhaust Fan	+24	101	When Guns Triggered
100	Ground	0	43	
101	Ground	0	87	
3	Not Used		9	
17	Not Used		23	
39	Not Used		46	
42	Not Used		49	
49	Not Used		59	
68	Not Used		101	
69	Not Used		105	

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FMC TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J4	CONDITIONS
70	Not Used		106	
71	Not Used		107	
76	Not Used		80	
77	Not Used		81	
78	Not Used		82	
79	Not Used		83	
88	Not Used		93	
97	Not Used		102	
98	Through 128 Not Used			
AA	Jumpered		1	Pin 1 to 5 to 6 (STE)

GE TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J3	CONDITIONS
01	Control Power	+24	79	TP-1 to TP-2
02	Power Logic OV Ref	0	7	Ground
03	HI Power	+24	10	TP-3 to TP-2
04	Drive System On	+24	9	TP-4 to TP-2
05	+12 VDC Trav	+12	47	TP-5 to TP-13
06	+12 VDC Gun EL	+12	67	TP-6 to TP-14
07	-12 VDC Tow EL	+12	89	TP-7 to TP-15
08	-12 VDC Trav	-12	48	TP-8 to TP-13
09	-12 VDC Gun EL	-12	68	TP-9 to TP-14
10	-12 VDC Tow EL	-12	90	TP-10 to TP-15
11	0 Degree Gyro Power	26VAC	43	TP-11 to TP-2 (800 HZ SQ)
12	90 Degree Gyro Power	26VAC	44	TP-12 to TP-2 (800 HZ SQ)
13	Trav OV Ref	R	86	(Jump 83) ±2 VDC Return
14	Gun EL OV Ref	R	87	(Jump 84) +9 VDC Return
15	Tow EL OV Ref	R	85	(Jump 82) ±12 VDC Return
16	Trav GNR Handstation	+12	59	(Jump 53) TP-16 to TP-13
17	Trav CMDR Handstation	+12	55	(Jump 52) TP-17 to TP-13
18	Trav Gun Gyro (9 Volts With Max VEH. Motion)	0 to +9 +0	57	TP-18 to TP-13
19	Hull Gyro (9 Volts With Max VEH. Motion)	0 to +9	58	TP-19 to TP-13
20	Trav Tach	41	56	TP-20 to TP-13
21	Trav Curr Sens	+0/3	51	TP-21 to TP-13

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GE TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J3	CONDITIONS
22	EL GNR Handstation	+12	66	(Jump 74) TP-22 to TP-15
23	EL CMDR Handstation	+12	72	(Jump 75) TP-23 to TP-15
24	Gun EL Gun Gyro (9 Volts W/Max VEH Motion)	0 to +9 +0	70	TP-25 to TP-14
25	Pitch Gyro (9 Volts W/Max VEH Motion)	0 to +9	69	TP-25 to TP-14
26	Gun EL Tach	+9	71	TP-26 to TP-14
27	Gun EL Curr Sens	+3	63	TP-27 to TP-14
28	Gun EL Pos Lim Pot	4.81	92	TP-28 to TP-14 (-9.62, -2.35@ -160 MILS) (-.5, + .5 @ 160 MILS) (4.81 @ 0°)
29	Gun EL Pos Pot	*	62	(Jump 60) *TP-29 to TP-14 (-2, -1.1 @ +160 MILS) (-1.1, +1.1 @ +160 MILS)
30	Tow EL Tach	+9	93	TP-30 to TP-15
31	Tow EL Curr Sens	+1.6	76	TP-31 to TP-15
32	Tow EL Pos Lim Pot	-4.00	91	TP-32 to TP-14 (-12.5, -2.0 Max Dep) (293) 12.5 @ Max EL) (-4 @ 0°)
33	Tow EL Pos Pot	*	77	(Jump 78) *TP-33 to TP-14 (-7.7, -5.5 @ Max Dep) (9.1, 11.3 @ Max EL)
34	Tow Lift Act Motor	+12	11	TP-34 to TP-2
35	Stab SW	+15	46	(TP-35 to TP-2

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GE TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J3	CONDITIONS
36	Raise Tow LHR SW	+15	45	(TP-36 to TP-2)
37	Tow Mode	+24	32	(TP-37 to TP-2)
38	GNR Palm SW Closed	+15	26	TP-38 to TP-2
39	GNR Rate SW Closed	+15	15	TP-37 to TP-2
40	CMDR Palm SW Closed	+15	25	TP-40 to TP-2
41	CMDR Rate SW Closed	+15	14	TP-41 to TP-2
42	Tow In-flight		24	W/MTC in Place
43	Vehicle Motion Contact		13	
44	Raise Gun to -1 Degree	+15	37	TP-44 to TP-2
45	Raise Tow to -13	+15	31	TP-45 to TP-2
46	GNR Drift SW	+15	33	TP-46 to TP-2
47	Stab Mode Contact	+15	12	(TP-47 to TP-2)
48	Popped Hatch		23	
49	Trav Brake	+24	16	TP-49 to TP-2
50	Gun EL Brake	+24	17	TP-50 to TP-2
51	Tow EL Brake	+24	18	TP-51 to TP-2
53	Man Intlck SW	+24	28	TP-53 to TP-2
55	Lift Up SW	+15	34	TP-55 to TP-2
56	Lift Not Up SW	+15	35	TP-56 to TP-2
57	Lift Down SW	+15	19	TP-57 to TP-2
58	Lift Not Down SW	+15	30	TP-58 to TP-2
59	Therm Sens	+15	20	TP-59 to TP-2
60	Tow Therm Sens	+15	36	TP-60 to TP-2
61	HI Power On Control	+24	21	TP-61 to TP-2
62	Tow Power On Control	+24	22	TP-62 to TP-2

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GE TEST POINT FUNCTIONS

TEST POINT	FUNCTION	SIGNAL	2A42J3	CONDITIONS
63	CMDR Drift SW	+15	38	TP-63 to TP-2
64	Trav GNR HS Shld	-	NC	(2A200J4-28)
65	Trav CMDR HS Shld	-	NC	(2A200J4-50)
66	EL GNR HS Shld	-	NC	(2A200J4-48)
67	EL CMDR HS Shld	-	NC	(2A200J4-49)
68	800 HZ Shld	-	NC	(2A200J4-36)
69	Tow Lift Brake	+24	27	TP-69 to TP-2
AA	Jumper	-	1	(Jump to 4)
BB	Not Used	-	8	(2A200J4-14)
CC	Not Used	-	29	(2A200J4-54)
DD	Not Used	-	80	(2A200J4-15)
EE	Not Used	-	94	(2A200J4-40)
FF	Not Used	-	95	(2A200J4-56)
GG	Not Used	-	96	(2A200J4-57)
HH	Not Used	-	97	(2A200J4-58)
JJ	Not Used	-	98	(2A200J4-59)

ITT CANNON

MINIATURE CIRCULAR CONNECTORS
KJL/KJ CONNECTORS

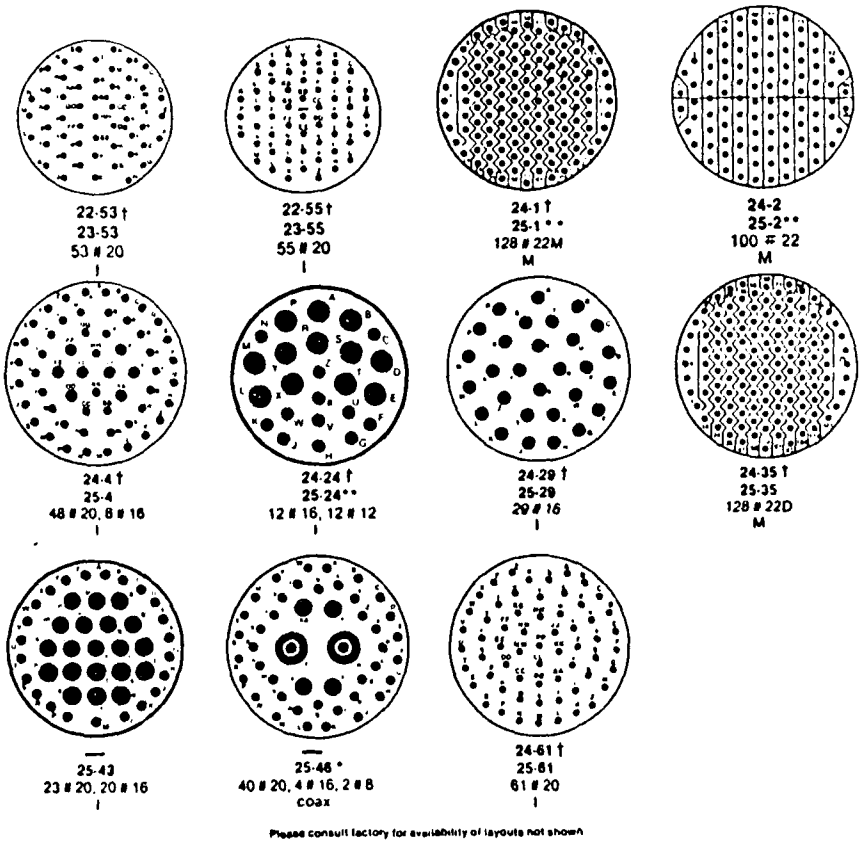
For immediate budgetary information contact the nearest office location shown on the back of this catalog cover.

CONTACT ARRANGEMENTS SERIES I and II

(ENGAGING VIEW PIN INSERT)

KJL contact arrangements designated in black.
KJ contact arrangements designated in color.

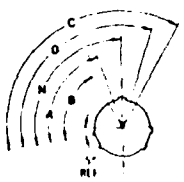
† Indicates layouts are available in all shell styles including MS27499, MS27508, KJ2E and KJ5E.
* Socket insert only
** Pin insert only (Not available in socket insert KJL)



Please consult factory for availability of layouts not shown

KJL POLARIZATION POSITIONS

See page 56 for KJ polarization.



Front face of receptacle. Insert arrangement does not rotate with main keyway.

Master Key/Keyway Rotation

Long Series I

SHELL SIZE	ANGLE OF ROTATION (Degrees) NORMAL	A	B	C	D
9	95°	77°	—	—	113°
11	95°	81°	67°	123°	109°
13	95°	75°	63°	127°	115°
15	95°	74°	61°	129°	116°
17	95°	77°	65°	125°	113°
19	95°	77°	65°	125°	113°
21	95°	77°	65°	125°	113°
23	95°	80°	69°	121°	110°
25	95°	80°	69°	121°	110°

CROSS REFERENCE BY NUMBER OF CONTACTS

No. of Contacts	Contact Arrangement	No. of Contacts	Contact Arrangement	No. of Contacts	Contact Arrangement
3	9-98	15	15-15	43	25-43
4	11-4	16	21-16	46	25-46
4	13-4	18	15-18	53	23-53
5	11-15	19	15-19	55	17-35
5	15-5	21	23-21	55	17-55
6	9-6	22	13-22	55	23-55
6	9-35	22	13-35	56	25-4
6	11-98	23	17-99	61	25-61
6	17-6	26	17-26	66	19-35
7	11-99	28	19-28	66	19-66
8	13-8	29	25-29	79	21-1
8	17-8	30	19-30	79	21-35
10	13-98	32	19-32	100	23-1
11	19-11	32	23-32	100	23-35
11	21-11	37	15-35	100	25-2
12	15-97	37	15-37	128	25-1
13	11-13	39	21-39	128	25-35
13	11-35	41	21-41		

APPENDIX B. REFERENCES

1. Bulletin No. CUB3T/R-B (Revised 2/87), Red Lion Controls, International Headquarters, 20 Willow Springs Circle, York, PA, 17402.

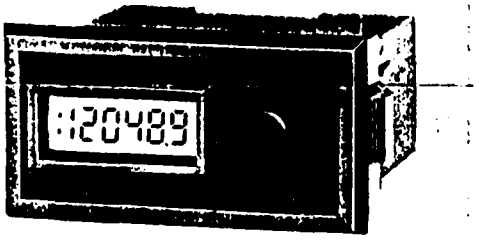
BULLETIN NO. CUB3T/R -B
REVISED 2/87

RED LION CONTROLS

INTERNATIONAL HEADQUARTERS
Willow Springs Circle, RD 5, York, Pa. 17402 (717) 767-6511
TWX: 510 657 4214 RLC YRK FAX: (717) 764-0839

EUROPEAN HEADQUARTERS
Cranford Lane, Heston, Hounslow, Middlesex TW59NQ
ENGLAND 01-759-0694 TWX: 24178 FAIRHO G

MODELS CUB3T & CUB3TR — GENERAL PURPOSE MINIATURE ELECTRONIC TIMERS



- 5½-DIGIT TIMER ACCUMULATES TIME IN HOURS OR 1/10 HOURS
- OPERATES FROM EITHER SWITCH CONTACT, 10-130V OR 60-260V (AC OR DC) INPUTS
- SELF-POWERED WITH INTERNAL LITHIUM BATTERY FOR UP TO 10 YEARS OF CONTINUOUS OPERATION
- AVAILABLE IN RESETTABLE AND NON-RESETTABLE MODELS
- EASY SNAP-IN MOUNTING IN 1" X 2" (25x50mm) PANEL OPENING
- IDEAL FOR PORTABLE, MOBILE, OR STATIONARY INDUSTRIAL EQUIPMENT
- WIDE TEMPERATURE RANGE (-30° C to +75° C)

DESCRIPTION

The CUB3T and CUB3TR are state-of-the-art products of Micro-Electronic technology. They open up a wide variety of new timing application possibilities that, until now, were economically impractical.

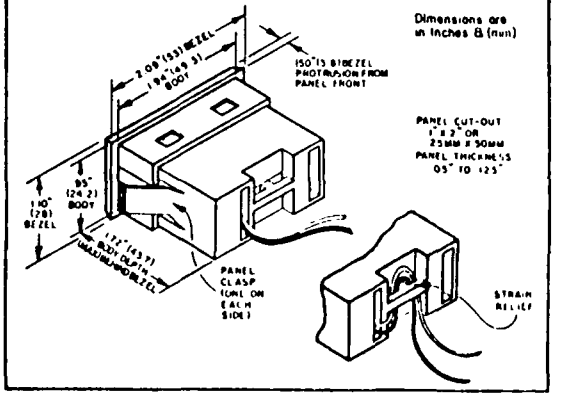
The CUB3T is designed to be used as an hour meter (or tenth hour meter) for continuous time measurement applications and is not resettable. The CUB3TR is a standard CUB3T which is user resettable. Both models accumulate time and display it on the 5½-digit LCD and are therefore capable of displaying a total of up to 199,999 hours (or 19,999.9 hours) before overflow. An indicator, resembling a colon (located to the left of the display), will blink (along with the decimal point of the tenth hour meters) whenever the timer is actuated. All timers are factory reset to indicate zero. The reset feature of the CUB3TR allows the user to periodically measure elapsed time. The CUB3T, on the other hand, is ideally suited for measuring total run time.

Application of the CUB3T is simplicity itself. Its rugged, reinforced nylon case snap-fits into a standard rectangular opening without screws or other hardware. Hookup is simply a matter of connecting two wires (four wires for the CUB3TR). No external power source is required since the internal lithium battery provides up to ten years of uninterrupted service. In addition to these advantages, the CUB3T offers integrated circuitry, embedded in a single monolithic, silicon micro-chip.

SPECIFICATIONS

1. DISPLAY: 5½-digit LCD, 0.2" (5.1mm) high.
2. POWER: 3V supplied by a non-replaceable Lithium battery. Nominal battery life is 10 years.
3. RESET:
   CUB3T - This version is a non-resettable timer.
   CUB3TR - A contact closure between the black and blue wires connects the internal lithium battery to the CUB3TR circuitry. To reset the CUB3TR, momentarily break this connection. A power up reset will occur.
4. SIGNAL INPUT:
   CONTACT VERSIONS - Switch contact or solid-state transistor switch. Contact burden 6uamps maximum. A closed switch will actuate the timer.
   10-130V VERSIONS - 10V minimum to 130V maximum AC or DC. Input current 150uamps maximum. Voltage applied to the inputs will actuate the timer.
   60-260V VERSIONS - 60V minimum to 260V maximum AC or DC. Input current 150uamps maximum. Voltage applied to the inputs will actuate the timer.
5. OPERATING TEMPERATURE RANGE: -30° to +75°C
6. ACCURACY: .025%
7. WEIGHT: 2 oz.

DIMENSIONS & INSTALLATION



WARNING - LITHIUM BATTERY MAY EXPLODE IF INCINERATED. INPUT VOLTAGE MUST NOT EXCEED 30 VDC ON CONTACT VERSIONS OR MAXIMUM RATED VOLTAGE VERSIONS TO PREVENT DAMAGE TO THE BATTERY.

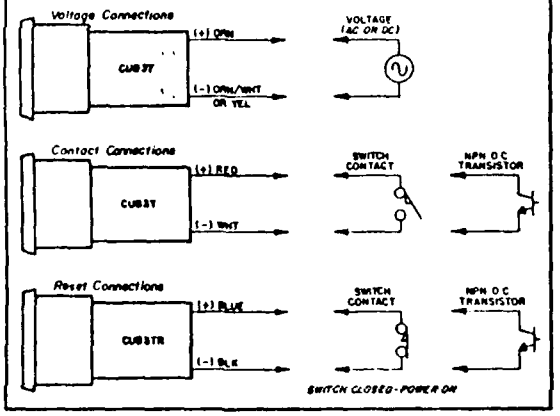
CAUTION - THE BLACK AND BLUE LEADS TO THE CUB3TR1'S AND CUB3TR2'S WILL BE AT THE SAME LINE POTENTIAL AS THE INPUT LEADS.

APPENDIX B

ELECTRICAL CONNECTIONS & INPUTS

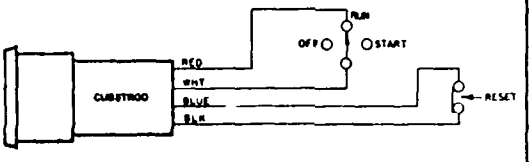
The CUB3T and CUB3TR can be supplied with input signals from mechanical switch contacts or solid-state switches (NPN or PNP transistors) as shown in the diagrams below. Reed switches, mercury-wetted contacts, snap-action limit switches, and silver alloy contacts with wiping action are usually satisfactory choices for mechanical switch input. Heavy "clapper-type" contacts such as used in contactors or large machine tool relays, tungsten contacts, or brush-type contacts are not recommended as input devices.

Signal input leads can be almost any type of electrical wiring for the "CONTACT" version. "VOLTAGE" version input wires must have the proper insulation as required by electrical codes. Noise immunity is provided; however, in extremely high electrical noise environments, twisted-pair or two-conductor shielded wiring may be used if required. Input leads should never be run in conduits, wiring troughs, or cable bundles with heavy power wiring.

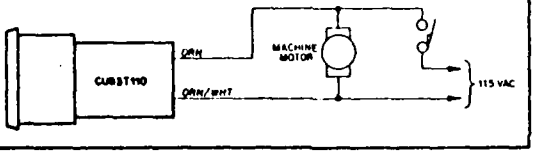


TYPICAL APPLICATIONS

An equipment rental company charges customers by the hour for the rental of fork trucks or other heavy equipment. To help determine the amount of actual run time, a CUB3TK000 is connected to a spare set of contacts on the ignition switch of the forktruck. When the switch is in the "RUN" position, the "Red" and "White" leads of the CUB3TR are connected, which causes it to accumulate time in hours on the display. The rental company simply resets the CUB3TR by momentarily opening the connection between the "Black" and "Blue" leads before each rental period. The normally closed "RESET" button should be protected to prevent tampering by the customer.



A machine shop manager charges customers for machine time by the hour. He is also interested in tracking machine run time vs. down time. A CUB3T110 connected across the 115VAC spindle motor of a drill press will serve both purposes. A reading taken before and after each job will indicate the actual machine run time in tenth hour increments. A reading at the beginning and end of each shift will indicate total run time, allowing the manager to evaluate production efficiency and down time.



ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
CUB3T	CUB3 Timer, Contact, 1 hr	CUB-3T-000/A
	CUB3 Timer, Contact, 1 hr	CUB-3T-010/A
	CUB3 Timer, 10-130V, 1 hr	CUB-3T-100/A
	CUB3 Timer, 10-130V, 1 hr	CUB-3T-110/A
	CUB3 Timer, 60-260V, 1 hr	CUB-3T-200/A
	CUB3 Timer, 60-260V, 1 hr	CUB-3T-210/A
CUB3TR	CUB3T Resettable, Contact, 1 hr	CUB-3TR-00/A
	CUB3T Resettable, Contact, 1 hr	CUB-3TR-01/A
	CUB3T Resettable, 10-130V, 1 hr	CUB-3TR-10/A
	CUB3T Resettable, 10-130V, 1 hr	CUB-3TR-11/A
	CUB3T Resettable, 60-260V, 1 hr	CUB-3TR-20/A
	CUB3T Resettable, 60-260V, 1 hr	CUB-3TR-21/A

RED LION CONTROLS

APPENDIX C. PARTS LIST.

MATERIALS REQUIRED:

Chassis	1 each	CU-3005A
Timer	4 each	CUB3TR11/A
Switch	1 each	MSP-103B
Diode	2 each	1N982
P4 Connector	1 each	MS3112E-8-4P
P3 Connector	1 each	MS3112E-8-4S
J4 Connector	1 each	MS3116E(or F)-8-4S
J3 Connector	1 each	MS3116E(or F)-8-4P
W1 Cable	16 feet	YR 22512 Mfg.: 16428 NSN: 6145-00-957-8519
Sealant		732RTV

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